Conservation Improvement Program in Minnesota:
Addressing an Organization Challenge with ArcGIS Online

Professional Paper

In Partial Fulfillment of the Master Degree Requirements

The Hubert H. Humphrey School of Public Affairs

The University of Minnesota

Nicola Brambilla

8/29/2017

Barbara Crosby, PhD.
Paper Supervisor

Paul Soper, PhD.
Second Committee Member

Table of Contents

Purpose

The purpose of this professional paper is threefold:

First, the paper introduces the topic of energy efficiency and related policy in Minnesota. This is achieved through a brief analysis of research showing the multiple benefits of energy efficiency and a deep dive into the Minnesota's energy efficiency/conservation policy known as the Conservation Improvement Program (CIP). This is intended to give the reader an overview of energy efficiency and the specifics of the relevant legislation in Minnesota.

The second goal of this paper is to identify an organizational challenge that the Minnesota Commerce Department's (Commerce) CIP team faces. This challenge has to do with a lack of CIP messaging and data visualization of CIP results and benefits. I addressed this challenge by making ArcGIS maps that display CIP information on the electric utility service territories in Minnesota. This culminated in an ArcGIS Online 'Story Map' that is intended to benefit Commerce staff by presenting easy to understand CIP quantitative and qualitative information for a legislative or general public audience.

The third goal of my paper is to explain the methodology for creating my ArcGIS maps. Commerce staff will be able to use this as a reference in order to aggregate, manage, and create future CIP maps.

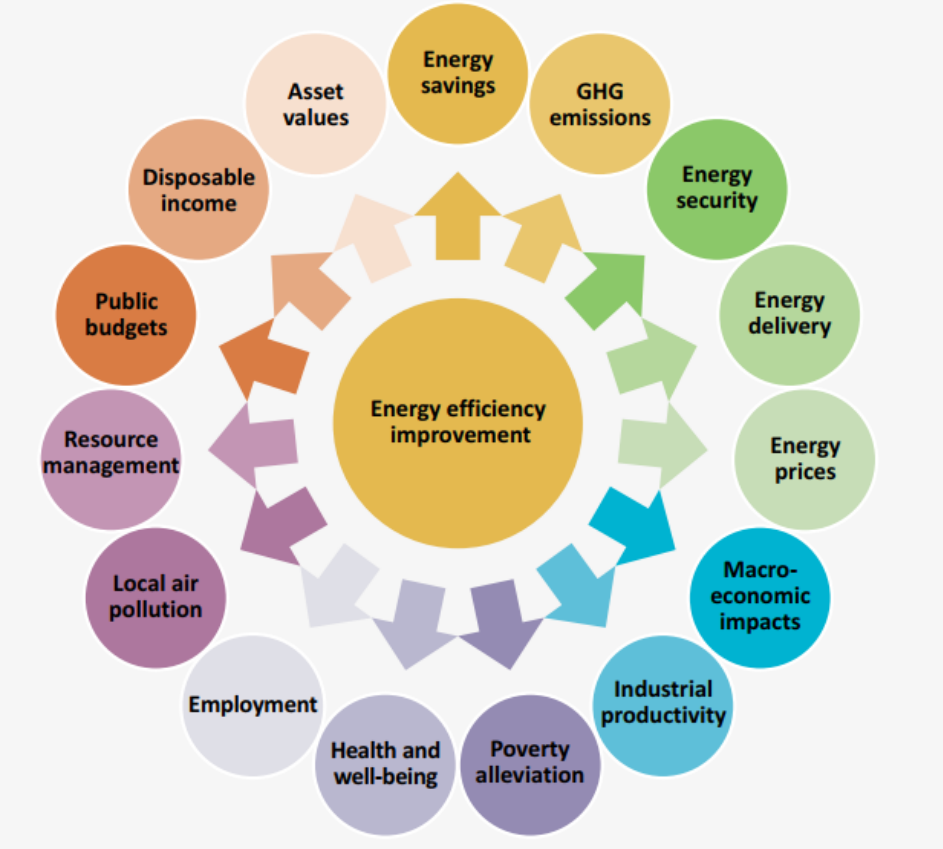
Benefits and uncertainties of Energy Efficiency

The U.S. Energy Information Administration (EIA) defines energy efficiency as 'using technology that requires less energy to perform the same function. Using a compact fluorescent light bulb that requires less energy instead of using an incandescent bulb to produce the same amount of light is an example of energy efficiency' (U.S. Energy Information Administration, 2017, pg. 3). Related to energy efficiency is energy conservation, which is defined by EIA as 'any behavior that results in the use of less energy. Turning the lights off when leaving the room and recycling aluminum cans are both ways of conserving energy' (U.S. Energy Information Administration, 2017, pg. 4). Together energy efficiency and

conservation can have transformative impacts on the U.S. energy system and economy. This is because energy efficiency and conservation reduces the amount of energy demand in the country, which has many direct and indirect economic impacts. The U.S. could reduce total energy consumption by a third, through energy efficiency and conservation improvements (Pimentel et. al, 2004).

Energy efficiency creates value in many economic sectors; moreover, energy efficiency has many social impacts. These impacts play a large role in growing the economy and improving energy security. The International Energy Agency (IEA) has compiled an analysis that goes through all the major benefits that are gained through energy efficiency, see Figure One. IEA estimates that the non-demand-reduction benefits have about 2.5 times the economic benefit of the demand-reduction benefits.

Figure One: Graphic showing the variety of benefits that is added from Energy Efficiency Improvements



However, the problem remains, many of the multiple benefits achieved are hard to quantify and thus are left out of the economic analysis. This economic analysis is used to determine the cost-

effectiveness of many energy efficiency programs. There are two uncertainties that arise when analyzing energy efficiency policies: the energy efficiency gap and the rebound effect. These are interesting problems because the former can be addressed with public policy while the latter is tougher to alleviate and may not even be a problem depending on how one looks at it.

The energy efficiency gap, also known as the energy efficiency paradox, is the well-documented 'failure' of consumers to make energy efficiency investments that would produce positive economic value for the consumer (Gillingham & Palmer, 2014). Many factors can contribute to this energy efficiency gap for consumers. Some of the most documented factors that contribute to this gap are a lack of information in the marketplace, implicit high discount rates for future energy rates, high upfront costs, and credit constraints that make it difficult for some consumers to make the investment in an energy efficiency upgrade.

The energy efficiency gap must be addressed through public policy that incentivizes and requires energy efficiency programs. Going forward this paper will address Minnesota's policy approach to energy efficiency and conservation.

Another unintended consequence of energy efficiency programs is known as the rebound effect. The rebound effect is caused when improving energy efficiency actually increases the energy demanded by a consumer. This seems antithetical to the entire energy efficiency process. A couple of examples can illustrate this problem. First, let us say a consumer buys a new energy-efficient fridge that consumes about half the amount of electricity compared to his/her previous model. The problem arises when the consumer decides to keep the old fridge in the garage or basement. This so called 'beer fridge' will be plugged in and consumes electricity all day and night. This is the rebound effect because at the end of the day the consumer is using more energy after the energy efficient upgrade than before.

Another example of the rebound effect deals more with the macroeconomic benefits of energy efficiency. As a society becomes richer and energy efficiency becomes the norm and disposable incomes rise as a result. This can lead to a society that overall uses more energy, even though citizens are using the energy more efficiently. However, this is may be considered a benefit to society that energy efficiency brings, if one values poverty reduction as a value of energy efficiency (IEA, 2014).

History of CIP in Minnesota

Minnesota has a noteworthy history of conservation and energy efficiency improvement policy. Starting in the 1980s, Minnesota required investor-owned utilities (IOU) to spend a portion of their revenues on conservation/energy efficiency improvements in the State.

At first, only large IOU were required to participate in conservation programs. This started in 1980 when the Minnesota Public Utilities Commission (PUC) directed utilities to initiate a 'pilot program' to demonstrate the feasibility of energy efficiency investments in Minnesota. The result of this study was that the PUC, and later the state legislature, set up guidelines for the IOUs that required 'significant' investment into energy efficiency. While this was a step in the right direction this policy change had little guidance on how the spending would be allocated or how much these utilities actually had to spend to increase energy efficiency.

Starting in 1991, a specific level of spending was required for all utilities investment into energy efficiency in CIP. The level that was set was 1.5% of gross operating revenue for electric utilities and 0.5% for gas utilities. This was an important development for CIP because it gave better guidance on how much money was required to be spent in energy efficiency and conservation investments. Moreover, this policy change included all municipal (Muni) and cooperative (Coop)[1] electric utilities to

[1] Muni and Coops are also known as Consumer Owned Utilities (COUs)

participate in the program. The inclusion of Munis and Coops is important because it opens up efficiency improvements to much of Minnesota's population who do not live in the IOUs service territory. Currently, a large percentage of Minnesota's population (about 2 million people) live in Munis or Coops service territories. Many small and medium sized cities provide electricity to their residents and businesses – and most of rural and agricultural Minnesotans live in Coops service territories.

Including Munis and Coops into CIP and requiring spending from these utilities is unique. Only one other state, Michigan, requires a majority of Muni and Coop utilities to participate in their equivalent of CIP (Downs and Ciu, 2016). The rationale behind excluding Munis and Coops may be that, in general, IOUs are the only utilities that are regulated by state's PUCs, meaning these utilities are constantly under review by a legal and analytical team that has the authority to approve utilities resource plans and rates. IOUs have this type of regulation because they are natural monopolies; having the government and a PUC regulate them is a necessary 'check' on monopolies to ensure reliable service at reasonable rates. It makes sense that IOUs, which are already under review and regulation, participate in state requirements of energy efficiency standards.

Munis and Coops run a little differently. Currently, in Minnesota, Munis and Coops have little regulation under the PUC. Some issues, like rates for customers who have solar panels, may be regulated by the PUC – but in general, the Munis and Coops have their own independent regulation. Coops have a board of directors who are elected by Cooperative members who then plan for resources, offer programs, and set rates. Similarly, Munis are run by the city government and have their own elected or appointed leaders who set rates and plan for resource requirements. Thus, many states have elected to not require energy efficiency spending and savings from Munis and Coops. While this gives these utilities more independence, it limits the amount of potential for energy savings for utilities, customers, and the state.

Overall, implementing a spending requirement for all utilities in Minnesota increased investments into energy efficiency. However, there was no mandated energy efficiency resource standard (EERS) that required all utilities in the state to achieve energy savings equal to a percentage of their total energy sales. Implementing a statewide EERS was one of the main achievements of Minnesota's 2007 Next Generation Energy Act (NGEA). The NGEA put into statute the requirements of savings and spending for most of Minnesota's electric and natural gas utilities to participate in CIP. This was the first time Minnesota enacted an EERS. Essentially, the EERS requires the utilities across the state to achieve cost effective energy savings for consumers.

Energy Efficiency Resource Standard

Before going into the specifics of the CIP statute, it is important to understand some of the key guidelines on how to evaluate an EERS in order to get a sense of some of the best practices across the country relating to this policy. The American Consortium for an Energy-Efficient Economy (ACEEE) has three guidelines for determining if a state's energy efficiency statute is an effective EERS, they are as follows:

1. Set clear long-term targets for electricity and/or natural gas savings

2. Make clear that targets are mandatory

3. Include sufficient funding for full implementation of programs necessary to meet targets

Minnesota is considered to have an effective EERS under these guidelines – in fact; Minnesota actually ranks sixth in the nation when comparing EERSs across the country (Berg et. al 2016). This is in part because Minnesota statute sets a high standard, funds the program adequately, and includes many unique provisions to help utilities achieve their energy savings goal.

The following CIP provisions apply to all electric utilities in Minnesota included all the Munis and Coops, which equals about 180 electric utilities. However, the CIP provisions only applies to a few

community owned utilities (COU) natural gas utilities whose retail sales are over 1 billion cubic feet of natural gas, meaning only five natural gas Munis participate in CIP. Most natural gas Munis are exempt from CIP – this exemption has always been present in the law since the NGEA of 2007. In general, it is harder for natural gas utilities to meet their CIP energy savings goals with cost-effective measures. Furthermore, most natural gas Munis have relatively small populations; thus, there is little potential lost energy savings by exempting these Munis.

Savings goals

In Minnesota, each utility is required to have an annual savings goal of 1.5% of its gross annual retail energy sales based on the most recent three-year weather-normalized average. This is an ambitious goal when compared with the rest of the country. Only eight other states in the US have higher electric energy savings targets (Berg et. al, 2016) with the highest being Massachusetts at 2.6% and Rhode Island at 2.4% savings targets a year.

The 1.5% energy savings target in Minnesota has a few exceptions. The first being that natural gas utilities are able to have a lower energy savings goal; this has historically been set at 1%. This is due to the lower cost-effectiveness/potential of natural gas energy savings that makes achieving high-energy savings more difficult. However, only about half of states with EERSs include natural gas utilities in their EERS. Only Massachusetts and Illinois have a higher natural gas EERS, both of these states set their natural gas EERS at 1.1%.

Another important CIP clarification relates to the funding of the program. CIP is funded through ratepayers, meaning customers. In general, each customer pays a little bit each month for CIP in order to fund the projects that are run by the utility companies. Related to this cost is a CIP provision that allows large commercial and industrial customers to 'opt-out' of CIP. This means that opt-out customers would not be allowed to participate in CIP but they would not be required to pay their share into the

CIP. This means that these industries would not be allowed to receive rebates or CIP technical support from the utilities they receive service from.

CIP opt-outs must be approved by Commerce. The CIP statute contains guidelines on the regulatory process Commerce must follow when approving opt-outs. The total opt-out numbers are not public, but in general around 50 customers opt-out of CIP equating around 10 billion kWh in sales. While that is a large number, plenty of potential sales are still eligible for CIP.

Spending Goals

The requirement that utilities spend a certain percentage of their gross operating revenue in energy efficiency improvements have not changed since the CIP legislation passed in the 1990s. Currently electric utilities are required to spend at least 1.5% of their previous year's gross operating revenue in CIP while natural gas utilities are required to spend 0.5%.

Most utilities do not have a problem meeting the spending goal when they are trying to meet the energy savings goal. In order to achieve the required amount of energy savings, utilities generally need to spend more than the statutory minimum spending requirement. This equates to more money being invested into energy efficiency projects in Minnesota.

An important aspect of the spending goals is the offer of a financial incentive for utilities to spend and save in CIP. This incentive allows the IOUs to reclaim a percentage of CIP spending relative to the percentage of energy saved in the previous year. Thus, IOUs are able to offset some of the costs that are associated with running energy efficiency programs. These costs come in the form of rebates and administrative costs but also the opportunity cost of lost energy sales. Thus, a utility that is saving energy is forgoing potential revenue in Minnesota because energy efficiency measures lower the amount of energy sales for a utility company.

Having some sort of financial incentive is an important best practice of an EERS policy, as it encourages large utility corporations to participate and perform well in the program (Downs & Cui, 2014). Historically, Minnesota has had the highest financial incentive in the country; this incentive rate structure was lowered in 2016 to reflect other states financial incentive mechanism (MN Public Utilities Commission, NO. G999/CI-08-133). Another drawback of this system is that COUs are not included in the financial incentive portion of the statute, since they are not regulated by the PUC. This results in a system where COUs have less financial incentive to invest in CIP, when compared to the large IOUs.

Cost-Effectiveness Tests

An essential piece of the regulatory review of CIP portfolio (which include all the energy efficiency programs and measures a utility runs) is the cost-effectiveness test. A cost-effectiveness test is an economic analysis of the CIP portfolio that determines if the benefits that the portfolio bring to the state are higher than the costs that are associated with the portfolio. However, there is debate over what should be considered costs and what should be considered benefits. Currently, Commerce requires utilities to report the cost-effectiveness of CIP programs from the utility, participant, ratepayer, and societal perspectives (Minnesota Rules Chapter 7690). See Figure 2 for a description of what is included in the cost-effectiveness tests.

Figure 2 : General Descriptions of Standard Cost-Effective Analysis (US Department of Energy, 2014)

Test	Acronym	Key Question Answered	Summary Approach
Participant cost test	PCT	Will the participants benefit over the measure life?	Comparison of costs and benefits of the customer installing the measure
Program administrator cost test	PACT	Will utility bills increase?	Comparison of program administrator costs to supply-side resource costs
Ratepayer impact measure	RIM	Will utility rates increase?	Comparison of administrator costs and utility bill reductions to supply-side resource costs
Total resource cost test	TRC	Will the total costs of energy in the utility service territory decrease?	Comparison of program administrator and customer costs to utility resource savings
Societal cost test	SCT	Is the utility, state, or nation better off as a whole?	Comparison of society's costs of energy efficiency to resource savings and non-cash costs and benefits

Source: Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.

Low-income Requirements

Another important requirement under CIP statute has to do with the equity of CIP and how energy efficiency should be targeted to low-income populations. The statute requires that utilities spend a percentage of their residential gross operating revenue to fund low-income CIP programs. Electric utilities are required to spend 0.2% of their residential revenue on these programs while natural gas utilities spending requirement was recently increased to 0.4%. These programs help thousands of low-income Minnesotans gain access to energy efficiency upgrades that can help them save money on their energy bills and gain more comfort in their homes. These low-income programs must also be available to low-income renters in Minnesota.

In general, these programs help low-income residents gain access to energy efficiency upgrades that they would not have access to without this spending requirement. Typical rebates do not cover enough of the costs of energy efficiency upgrades that make them accessible for low-income residents.

Many low-income CIP programs partner with other weatherization organizations that offer furnace or water heater replacements to those in need. Insulation upgrades may also be covered under these programs to tighten up the entire home, thus improving comfort and reducing energy bills.

Some studies have shown that energy efficiency upgrades are an equitable and effective way of raising people out of poverty; by lowering the energy costs that can take up a large portion of one's wages (EPA, 2017). Moreover, Commerce generally allows utilities to overspend in low-income programs. This acknowledges that cost-effective testing does not show the full picture of benefits especially in terms of programs that provide equity to the state.

Conservation Applied Research and Development (CARD)

Another aspect of the CIP statute is the funding of applied research and development grants that Commerce is allowed to allocate $3.6 million dollars a year. These grants must be allocated to maximize energy savings, improve the effectiveness of CIP, or document energy savings. The money is distributed through a rigorous and competitive grant proposal period; typically, several dozen non-profit energy organizations and other energy related stakeholders submit proposals for Commerce's review.

Generally, these grants are focused on a new energy efficiency technology that needs field-testing or verification to help support adoption and implementation in utility CIP portfolios. Commerce has funded several projects that apply to every sector of Minnesota's economy and energy needs, including residential projects, multifamily projects, commercial projects, industrial projects, and agricultural projects.

Last year Commerce funded a statewide energy efficiency and utility infrastructure potential study. This ambitious project will calculate the remaining potential for energy efficiency upgrades that are available to the state over the next decade. This study will calculate the technical, economic, and maximum achievable potential of energy efficiency while also looking at several different emerging

technologies that can be implemented in Minnesota. This study will inform utility and state decisions going forward on the future of energy efficiency in Minnesota.

Recent Results of CIP

Since 2011, Minnesota's electric utilities on aggregate have met their energy savings target of 1.5% in every year. Natural gas utilities have met or exceeded their energy savings target in five out of the past six years.

Figure 3: Electric Savings and Expenditures 2010-2015 achieved by CIP participating Electric Utility Utilities

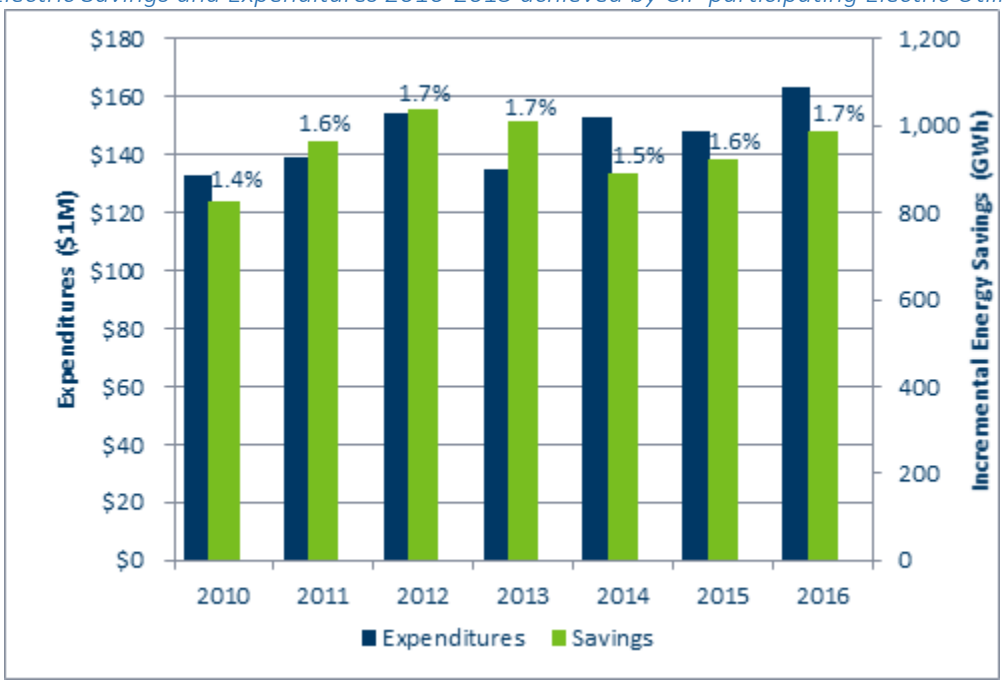


Figure 4: Gas Savings and Expenditures 2010 -2015 achieved by CIP Participating Natural Gas Utilities

In total, Minnesota utility companies have done an excellent job in meeting their CIP savings requirements while investing millions of dollars into energy efficiency programs. In fact, 2016 was CIP's most productive year in total energy savings.

Recent Legislative Challenges for CIP

In Minnesota, energy policy is highly contested. In 2016, Republicans won a majority in the Minnesota Senate and expanded their majority in the Minnesota House. This meant that Republican legislators took control of many important positions in the Minnesota Legislature. In particular, Republican legislators took control of the energy policy committees in the House and Senate. Having control of these committees comes with a lot of legislative power especially in terms of controlling the policy agenda that goes forward. A key theme of the recently completed 2017 legislative session was Republican legislation targeting the regulation of the energy sector in Minnesota, including CIP.

A majority of the legislation was intended to remove regulatory power from the Minnesota Public Utilities Commission (PUC) and give it to either utility companies or the legislature. Examples of this type

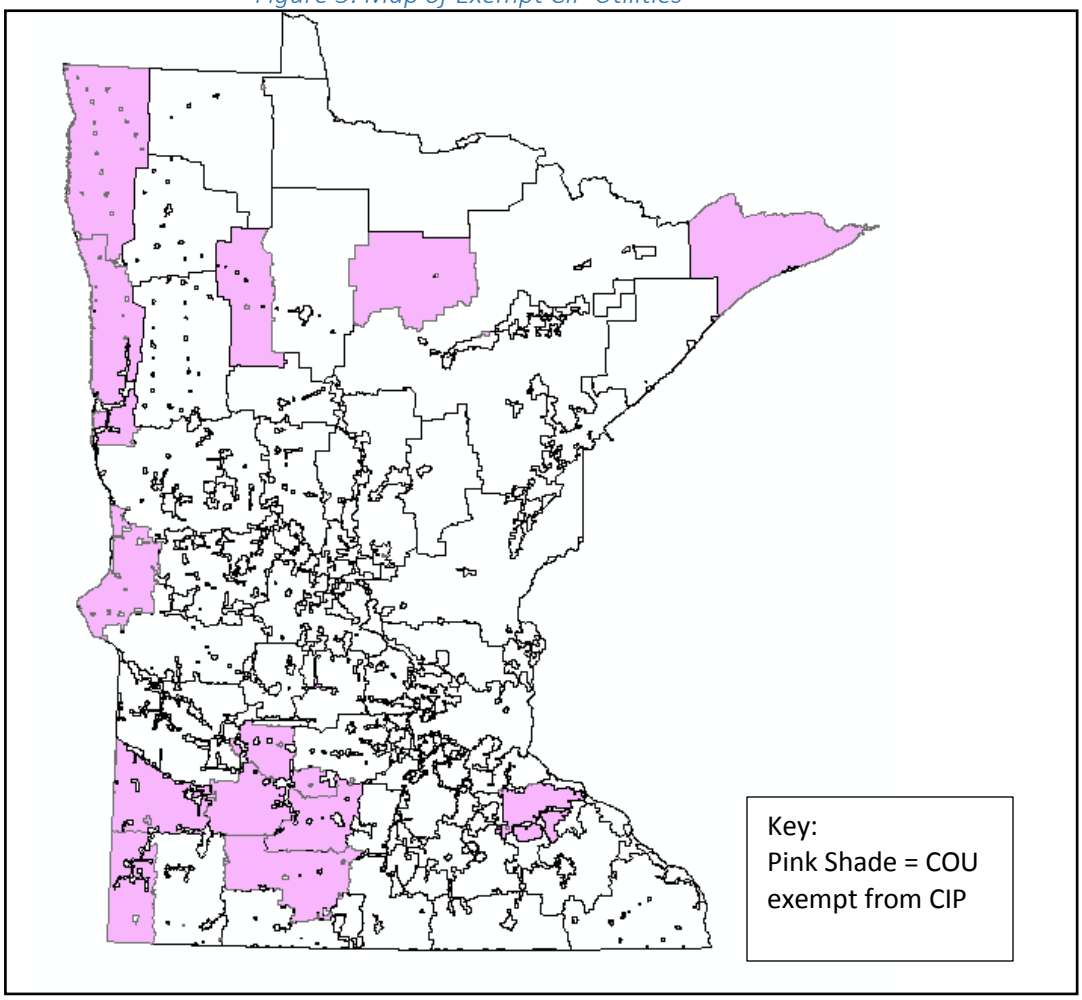
of legislation include a bill that would have given the Coops and Munis more authority to settle disputes with customers without PUC oversight and a bill that dramatically changed the way the Renewable Energy Fund is administered.

The way the legislature went about changing energy policy this session is meaningful. Most of the policy changes that affected energy policy in Minnesota were passed via the Economic Development and Energy Omnibus bill. This Omnibus bill is actually the funding/spending bill that funds the Minnesota Commerce Department, the Minnesota Department of Employment and Economic Development, and the Minnesota Department of Labor and Industry. If the Omnibus bill did not pass then these state departments would have shut down on July 1, 2017. Governor Dayton went through a total state government shutdown in 2013 and an analysis of his rhetoric made it clear that he wanted to avoid a shutdown in 2017. This means that compromise was needed to fund the state government through Omnibus bills.

The Governor of Minnesota has limited veto power in the state –meaning that Governor Dayton either had to veto the entire Omnibus bill to send it back to the legislature or sign the entire bill including its many energy-related policy provisions. After negotiations, Governor Dayton signed all the Omnibus bills into law – thereby avoiding a government shutdown. However, many of the policy provisions that were placed in the Omnibus bills were controversial and may have unintended consequences across Minnesota.

One of the controversial policies had to do with the CIP law. This policy provision changed the CIP law by exempting small COUs from participating in the program. The bill states that Coops with less than 5,000 members and Munis with less than 1,000 customers are exempt from the CIP law. In total, this excludes about 50 Munis and Coops across the state.

Figure 5: Map of Exempt CIP Utilities



In total the exempt Munis and Coops serves about 130,000 people. These customers will, most likely, no longer have access to the energy savings programs and rebates that would reduce their energy bills.

While it seems the policy trend in Minnesota is moving away from the EERS and CIP participation for smaller Munis and Coops – there is actually a policy proposal (supported by Governor Dayton's Administration) that is pushing to increase the CIP EERS savings standard to 2% from 1.5%. This policy recommendation came out of the Climate Solutions and Economic Opportunities Report in 2016. This report analyzed various policy options that would reduce Minnesota's overall greenhouse gas emissions in the state. The report analysis estimated that increasing the CIP EERS savings standard from 1.5% to

2% would reduce emissions by 4 million tons and help improve Minnesota's economy by adding 1,500 energy efficiency-related jobs. While this policy proposal was highlighted by the Dayton administration in 2016 and 2017 – little legislative action has taken place to implement the expansion of the EERS to 2%.

CIP Organizational Challenge

The recent legislative change that decreases the amount of utilities required to participate in CIP and the lack of legislative action on increasing the CIP EERS relate to the organization challenge that I have been addressing with the Commerce's CIP team: not enough, ready-to-go, compelling information and messaging on the performance of CIP in Minnesota. Specifically, there is not enough data visualization of important CIP performance and benefits that is easy to understand for policy makers and organizations that influence the direction of CIP in Minnesota. Over the course of a few months, I have been developing a CIP mapping project that mixes qualitative and quantitative CIP data into a user-friendly platform, ArcGIS Online. This tool is a good message to start with for stakeholders who may not understand the array of benefits CIP brings to Minnesota.

Relevant Stakeholders

When starting my project to improve CIP messaging and data visualization of CIP data I needed to identify and analyze important stakeholders who are the targeted audience for my mapping and data analysis project. Below is a list of the three most important stakeholders who are the intended audience of my project, paper, and maps. This is in no way a complete list of relevant stakeholders, but keeping these stakeholders in mind helped me understand and execute my CIP project.

Commerce Staff

The first stakeholder for my project was my co-workers and management of the Commerce organization. It is important to understand their needs so that my maps and other deliverables are relevant and can help them meet their organizational goals and assist them in their analytical work.

Having a mapping tool available that is easy to use is important for Commerce staff for many reasons. First, it is a way to connect with CIP data, which they work with every day, in new ways by displaying CIP information on an easily recognizable map. In addition, it is important that this information is easy to access and easy to edit if changes or improvements need to be made.

This project also is addressing Commerce's need for more CIP messaging that can be ready when/if legislation comes up that proposes to dramatically change CIP. Thus, the information and product must be compelling to outside stakeholders.

Legislators and Policy Makers

The main external stakeholder that I am focusing on is Minnesota policy makers, in particular skeptical Republican legislators who may want to eliminate or reduce the authority of the CIP statute. While no one map or graph will alter the ideological position of any legislator, having ready to go and easy to understand information that highlights a few key points about CIP may go a long way to gain some support for keeping CIP as is. That is why my project highlights economic and utility benefits that accrue cost-effectively across Minnesota. Furthermore, there is the potential of targeting specific legislators who may be in powerful committee positions with 'district pages' that highlight CIP in the legislative district or counties they represent. These pages would simplify CIP results and only cover a few economic highlights.

Furthermore, it is important to target legislators who may be proponents of CIP but may not understand all the benefits of the program. This would have the benefit of increasing awareness of CIP and make legislators who are supportive of CIP into potential policy 'advocates'. A policy advocate would be a legislator who takes up CIP as a main policy goal. This would elevate the expansion of the EERS on the policy agenda. Moreover, it may be harder for legislators to eliminate the program if there are many legislators, or even the governor, who believe that CIP is too important to eliminate.

The General Public

I doubt most people in the state know what CIP is. It is hard for Commerce to target the public because most people interact with CIP through their utility company. Thus, while people may have a general understanding that LED lightbulbs are more energy efficient they do not connect the CIP statute with those benefits. Thus, my project potentially has an opportunity for Commerce to increase their outreach through the web-based ArcGIS maps I created. These maps would allow residents to type in their city to see not only the utility that provides them electricity but some of the most important CIP performance statistics. Qualitative information also is available to describe some of the programs that are available to customers. This project is another tool for Commerce to target the public at large and at least give them the basic information of what CIP is, how it works, and how it helps them save money on their energy bills.

Current Commerce CIP Messaging

In order to understand the needs of the Commerce Department it was important for me to get a sense of the information that is already produced by Commerce relating to CIP and the benefits it provides. While a high amount of quality information exists, a person without in-depth knowledge of the program may not necessarily understand the benefits that CIP brings to Minnesota.

I will highlight two pieces of CIP information that are currently available. These are important resources but may not meet the needs of all the stakeholders Commerce would like to target.

Energy Savings Platform

Energy Savings Platform (ESP) is a cloud-based software that is available for utilities and interested parties to access. ESP provides a lot of quantitative information on how utilities perform in CIP. This software helps utilities track and verify their spending and savings. ESP is also helpful for Commerce staff to analyze CIP results.

However, this program is not very user-friendly because it is not targeted to a wider audience. The information is presented in large spreadsheet-like pages that require a lot of analysis to understand. Furthermore, there is not a lot of aggregated information, meaning that it is hard for a user to find the total amount of energy saved in Minnesota through CIP.

Thus, while this software plays a role in helping utilities and Commerce staff meet CIP requirements it is not a tool that can be easily used for stakeholders to understand CIP and how CIP performance affects Minnesota.

CO2 Report

Another piece of information the Commerce Department produces is a CO2 report. Which is mandated in the CIP statute. Each year the Department of Commerce must submit a report that analyzes the CIP performance in terms of estimated CO2 reduction from the previous two years.

While this report is a useful piece of information that shows the CIP performance of utilities across the state and includes some helpful facts about what the energy reduction means – the report is very text heavy and a busy legislator or stakeholder may not have enough time to read the entire report and understand its significance. Furthermore, the report does not focus on all the benefits CIP brings to Minnesota because it is focused on CO2 reductions.

In sum, while the report is a useful exercise and may be helpful for some, it is very text heavy, the key messages are hard to ascertain with a quick skim of the report, and the report does not highlight all the important benefits that CIP brings to Minnesota through energy efficiency upgrades.

Ways to Present Benefits of CIP

Before getting into the methodology of the mapping project, it is important to discuss the ways I will be presenting CIP data. This section highlights some recent research that shows the economic,

utility, and environmental benefits that CIP programs produce in Minnesota. The research shows four major categories of benefits: economic, consumer, utility and societal.

Economic

A recent CARD funded study – carried out by Cadmus – assessed the total economic impact CIP has had on Minnesota's economy from 2008-2013. This very in-depth economic review went through the cost-effectiveness of CIP while analyzing the 'employment, employee earnings, household income and savings, business revenue, industry production, capital investment and innovation, and state domestic product' effects CIP has in Minnesota. The key takeaway from this study is that each dollar invested, through CIP, returns $4-4.30 to the state's economy (Cadmus, 2015). This is the baseline number I used for my analysis in the mapping project. However, I used the more conservative estimate of a 4:1 return on investment for the state's economy.

It is also important to analyze the jobs that CIP creates and compare those job's wages to the state average. This is especially important because many legislators are concerned with the intersection of energy and employment in Minnesota. For example, in 2017 the legislature fast-tracked the approval of a new natural gas plant in Sherburne County, in part because of the jobs the plant would create. According to the Cadmus report, from 2008-2013 CIPs net job creation was about 55,000 jobs – with employee earnings around $3 billion dollars. Furthermore, a report put out by Minnesota National Governors Association (NGA) in 2014 – showed that there are about 9,500 jobs in the energy efficiency field and these jobs have an average salary of $73,000, which is more than $20,000 over the Minnesota annual mean wage.

Consumer Benefits

Another major benefit of CIP is that energy efficiency upgrades will lower residents or businesses utility bills. This is important for many reasons. Businesses are on tight budgets in Minnesota and every dollar saved on energy goes back to their bottom line. This money can be reinvested in the

business and potentially create additional jobs in Minnesota. Similarly, residents electricity bills are a major utility bill that is paid monthly; by lowering their bills through consumer energy efficiency they save money that can be spent on other goods and services.

For the purpose of this project, I needed to find an average price of electricity for the entire state of Minnesota. I used information from EIA to come up with 12 cents per kWh as an average price that is appropriate to apply to all energy sales in Minnesota. This average takes into consideration rates from all the utilities in Minnesota and a variety of different rate structures for different customer classes.

It is also important to note that CIP energy savings data is reported and analyzed on a 'first-year' savings estimate. This means that only savings that come from the energy efficiency upgrade from the year it is installed in counts towards savings goals. However, most energy efficiency upgrades last many years and thus save energy and money for multiple years. For my project I used an average lifetime of 15 years for energy efficiency measures – this lifetime is considered appropriate by Commerce.

Utility Benefits

Energy efficiency would not work without substantial buy-in from utility companies. Utility companies receive many benefits from improving energy efficiency through CIP. This may seem counter-intuitive since CIP reduces energy demand, meaning utilities sell less energy. The data is clear; utilities receive more monetary benefits from energy efficiency than it costs.

Energy efficiency and CIP are seen as a least-cost resource for utility companies. This means that it takes less money to save a unit of energy through CIP than it does to produce and deliver a unit of energy to a customer. Furthermore, Minnesota does not have any natural gas or coal in the state; thus, utility companies must import the fuel into the state, adding more costs to produce energy. Overall, CIP costs about $10 per MWh while natural gas costs or wind generation cost about $73 per MWh (Commerce Dept., 2016).

Utilities receive other benefits from energy efficiency. First, energy efficiency, by reducing the energy load, makes it easier for utilities to plan their resources. This means that energy efficiency lessens the need for building new generation plants in Minnesota because the load is going down. Planning for a new generation plant is a hassle and takes several years to complete. CIP programs can be easily ramped up or down depending on the needs of the utility. Thus, CIP makes utilities in Minnesota more reliable by giving them more flexibility in their resource plans and saves them money by reducing generation costs.

Societal Benefits

The last category of benefits that I analyzed in my project were societal benefits. These benefits mainly deal with how energy efficiency reduces greenhouse gas emissions in Minnesota. With the NGEA of 2007, Minnesota set a very high carbon emission goal: 80% reduction from 2005 baseline by 2025. Currently, Minnesota is not meeting its carbon emission goal. However, CIP plays an important role in reducing carbon emissions in the state.

My project uses the same EIA data source for carbon emissions that is used in the CO2 report. Overall, since 2006 CIP programs carbon emissions reduction is equivalent to removing every passenger car from the road in Minnesota for one year.

Methodology of Mapping Project

Why GIS?

Geographic Information Systems (GIS) technology is an innovative tool that can be adapted to be used on almost any data set. One of the main benefits of GIS is that it allows a user to display data visually on a map. This helps the user and the audience visualize the distribution of data in order to make important assumptions and connections with the data. Thus, GIS allows the data to be more

widely understood by the public. This is important for Commerce Staff because they have not had many ways to present CIP other, other than tables that get complicated with many utilities crammed into rows on a spreadsheet.

Earlier this year, Commerce Staff expressed interest in displaying CIP information in GIS maps; but they did not have the resources in this project. This summer I was able to use my newly acquired GIS skills to spearhead the GIS mapping project for Commerce.

Why ArcGIS Online?

ArcGIS maps have the limitation that inserting qualitative information into the ArcGIS maps is difficult; and ArcGIS is only accessible to people who have the software. Of course, one can create a pdf of the maps that are created in ArcGIS but that would present a static picture of CIP that may not be user-friendly.

To address both of these problems I utilized a tool that I learned in the Humphrey School. This tool is called ArcGIS Online, which allows the author to create, host, and share innovative mapping projects. Using ArcGIS Online solved the second problem immediately – with ArcGIS Online anyone who has the appropriate link to the map and an internet connection can access the map. This helps allow Commerce to highlight and market CIP results. Potentially, Commerce could send the map link to email newsletters lists or host the link on the Commerce CIP webpage. Furthermore, when mapping information is stored on ArcGIS Online, the information is safe from accidental deletion or computer system failure. The author of the map also has control of who can see the maps and who can make edits to the maps. These capabilities allows more security for the author and allows one to edit a map before it is ready for public consumption.

Another benefit of ArcGIS Online is that it is very user-friendly. This is especially true when one is looking at an already created map. The program similar to Google Maps or Google Earth where the

user can zoom in and out, search features, and click on points of interest. Moreover, the data that is displayed on the map itself is editable so that the author of the map can control the information that is displayed on each map. For example, a map showing county level energy savings can be edited so that when a user clicks on their home county an information box pops up that not only shows total energy saved but also total reductions of CO2 emissions achieved. This allows more quantitative information being presented on a single map.

Presenting CIP information in ArcGIS Online helps Commerce Staff reach multiple stakeholders. Moreover, ArcGIS Online solves the first problem addressed above by allowing authors to create user friendly 'Story Maps' that allow the author to develop multiple maps on a topic and add qualitative and narrative text information. This allows the author to break down the complicated CIP information into short 'slides' that present one part of the CIP story with a map and narrative text that highlights the qualitative information. In sum, a Story Map allows the user to understand the complete picture of CIP and how it performs in Minnesota.

ArcGIS and ArcGIS Online software are available to Commerce staff, even with access to the software, getting CIP data into ArcGIS is not an easy task. There are over 180 utilities in Minnesota and a lot of CIP data. Making sure that the data and calculations are comprehensive and accurate is essential.

Data currently available for this project

The key base map (also known as a shapefile) for this project is the already existing map that shows the current electric utility service territories (ESUT) of all the 180 electric utilities companies in Minnesota. Without this map it would be almost impossible to create GIS maps that display CIP data in an easy to understand way. Luckily, this map exists and is publically available. This map was created by the Minnesota Public Utilities Commission (PUC) in 2015 and is available through Minnesota's Geospatial Commons.

Since the Minnesota EUST map is the base map for my project, it is important to understand the metadata record that is kept on this Shapefile to ensure that best practices were used in the creation of these service territories, and that the map is updated regularly to display relevant changes in service territories and to correct any errors that have been located. After looking at the metadata records (Minnesota Geospatial Commons, 2015), I concluded that the methodology of this base map is sound.

First, the metadata record goes into the process of creating the EUST map by referring to the old hand-drawn maps that were available beforehand. The PUC then used advanced scanning and processing technology to create polygons for each electric service territory. The goal of this project was to accurately depict the service territories with a margin of error of +/- 60 feet. Thus, the map that was created was accurate enough to be statistically significant for the CIP maps that I created. Furthermore, the metadata record shows that the PUC also took into consideration stakeholder feedback to ensure that the hand-drawn printed maps were still an accurate reflection of the service territories. These comments are publically available and were taken into consideration when the final maps were created. Moreover, in 2014 an IOU that was operating in Minnesota, Interstate Power and Light, left the state. This meant that several Munis and Coops acquired the old, Interstate Power and Light service territory. When the final decisions were made on what utilities acquired the old, Interstate Power and Light territory. New service territories were created and the PUC EUST map was updated to reflect those changes. Lastly, the metadata is clear that EUST map can be edited and updated to reflect any errors that are present in the map or to update any changes that may happen to the service territories in Minnesota.

Limitations of the mapping project

The main limitation for my mapping project deals with the way utility companies in Minnesota report their CIP data. Utility companies report their data, to Commerce, in aggregate, meaning they report their spending and savings numbers at the entire utility level. I hoped to get CIP saving and

spending levels at the county, city or zip code level, but these numbers do not exist and trying to get these numbers from utility companies would be problematic due to 'trade secrete concerns.' Thus, for my project I created estimations (based on population) for county-level maps that display CIP data.

The last limitation for my mapping project deals with the lack of a map of the natural gas utility service territories in Minnesota. Natural gas companies claim their service territory is trade secret. However, I have been in discussions with an organization, Seventhwave, which is working on a natural gas service territory map that uses cities for the natural gas utility service territories. Going forward, I am optimistic that I will be able to replicate the process for electric service territories for the natural gas maps that are forthcoming.

Step One: Data from Energy Savings Platform

The Energy Savings Platform (ESP) supplied three key pieces of information for my mapping project: the achieved savings data from the 180 reporting utilities, the CIP spending totals for all the electric utilities, and the sales data from the utilities from the reporting data. The sales and savings data collection was straightforward; however, ESP is not the most user-friendly platform so I had to copy and paste many "Results & Analytics" data under the 'Organizations 'section.

The sales data was a little more challenging since the total sales used for the energy savings goal is under the individual 'Organizations' Section. This is different from the number in the 'Results & Analytics section under Organizations.' This is because the savings goal is based on the three-year average of sales two years before the reporting year. For example, for 2012 the savings goal for a Muni electricity utility would be based on 1.5% of its average sales in 2008-2010. In order to ascertain these numbers I used a flat query to create the 'raw' ESP data into pivot tables where I was able to create a formula that calculated the correct sales number for most of the utilities. Some utilities had 'exempt' sales, which made the formula invalid so I marked those utilities and then manually went to their "Organization – Results" page to get the correct sales data for 2012-2016.

A few caveats for this data are worth mentioning:

First, IOU data is reported a little differently in ESP – thus for IOUs I used Status Report Filings (located on Minnesota's eDockets website) to get the correct sales, savings, and spending data needed.

Second, a few generation and transmissions (G&Ts) organizations report some electric utility infrastructure savings reported at the aggregator level. These savings are not included in my data collection process, but I noted where they occur. These savings are not included because they would be difficult to map, but these savings could be included in a map that shows results at an aggregator level.

Step Two Enriching the Sales, Savings, and Spending Utility Data

After the data was verified I was ready to create some new attributes (otherwise known as fields) for the utilities. First, I created a dummy variable – for the newly exempt electric utilities. Thus, around 50 utilities were inputted as a 1 for this field and the rest received a 0 for this field. Another, qualitative field I added to the utilities was which aggregator organization they are in, most Coops and Munis report their aggregated CIP data through their G&T organization.

The other qualitative fields I added to the utilities dataset dealt with economic benefit of the utility, bill savings in the service territory, CO2 reductions, and lifetime benefits associated with the savings and spending. In short, I used recent EIA data to convert the achieved energy savings data into CO2 reduction in tons, and bill savings. For bill savings, I used the statewide average price of electricity, $0.12. I then added in some social math calculations that converted energy savings into equivalent cars removed from the road and homes powered per year (EPA, 2016). The economic benefit achieved through the program was based on the Cadmus report data mentioned in a previous section.

In addition, I converted the achieved savings data, and subsequent calculation, into lifetime savings, mentioned above the average lifetime of measures is 15 years.

Step Three: Analyze PUC Electric Utility Service Territory (EUST) Map and prepare for the merge of CIP and EUST data

However, I needed to take a few steps to make sure the CIP data and the EUST data merged correctly. First, I needed to get the naming conventions of the utilities the same; this is an important step because in order to merge data in ArcGIS there needs to be at least one identical attribute field in each data set. I chose to merge the utilities based on name to ensure consistency in the merge. However, in the EUST data, the naming of the utilities was moderately different from the naming of utilities in ESP. For example, in the EUST data the attribute for the name of a Muni utility is East Grand Forks Water and Light Department while the data from ESP has the same utility name field as East Grand Forks Water & Light Dept. In short, many name edits were completed to ensure a correct merge.

Another difficulty with the EUST data that needed to be fixed was some duplicate utilities. Several utilities, like Springfield Municipal, appeared twice in the data set and this created two separate polygons representing the same service territory. To alleviate this I dissolved the duplicate polygons based on their name attribute. This in effect merged the separate polygons and duplicates into one based on their unique name, this not only simplified the merge process but also came in handy when I added population statistics to the utilities.

Another problem with the EUST map was the inclusion of about 40 square miles of empty spaces on the map. These areas are mentioned in the EUST metadata as areas where there is a possible dispute between the utility companies about who provides electricity in this area. This is a small part of Minnesota (mainly rural areas with a total population of 2,000). Luckily, for my project Seventhwave, an energy research non-profit organization, has been working with Commerce this summer on an energy efficiency potential study. One of their tasks has been creating GIS maps to present their results of the

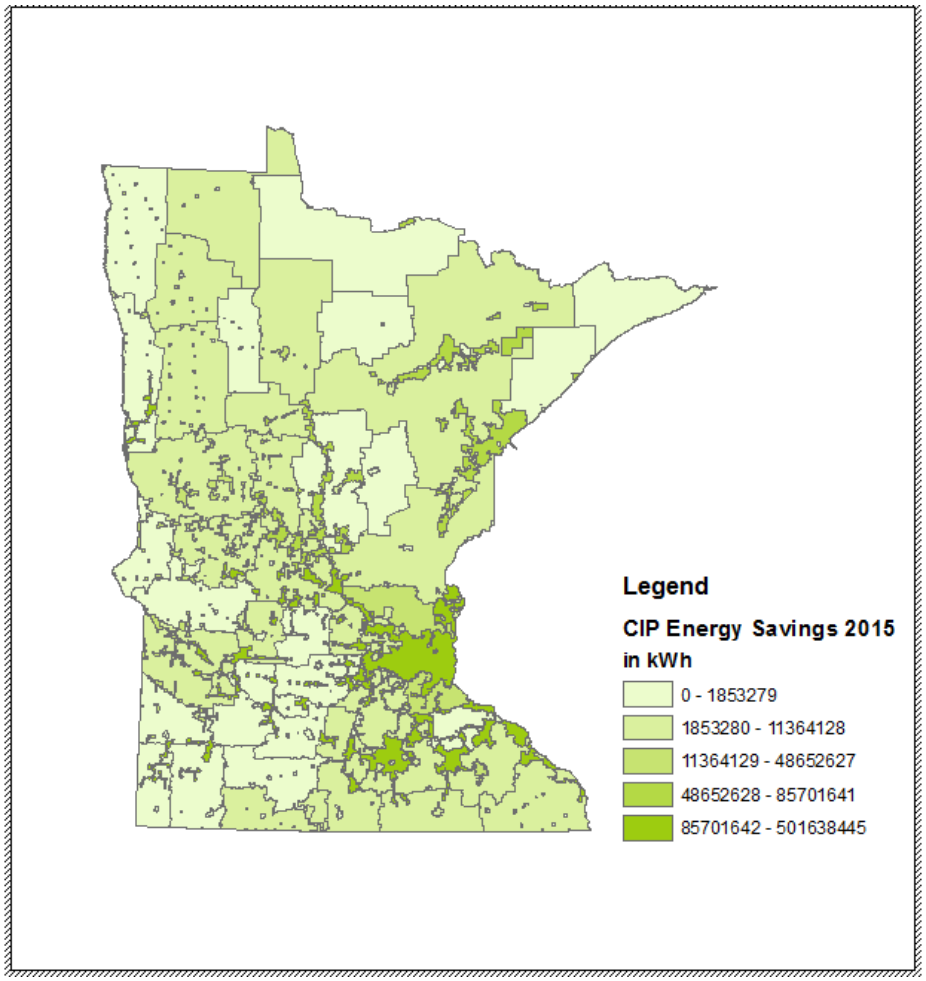
potential study. In short, they created a new EUST base shapefile that adds in information to the blank areas. I used this map going forward in my project.

Now that everything from the PUC map is fixed and the names of the utility companies are identical I was ready to merge the EUST map with the Excel document of the CIP data. However, ArcGIS works better with comma-separated values (CSV) Excel documents, so I copied my normal Excel document and then I converted the normal Excel document into a CSV file. This step is important because a CSV Excel gets rid of the formulas that are used to create many of the attributes. Once, the CSV file and EUST shapefile were imported into ArcGIS I used the join and merge function which combined the CSV attribute table with the EUST attribute table. This is a simple last step to merge and join this data but the results are important because now I could manipulate and display CIP data in a number of different ways.

Step Four: Normalization of Data

Now that the data was merged, I could use ArcGIS functions to display the results of the CIP performance. Figure 6 is a quick example showing achieved energy savings in 2015.

Figure 6: CIP Energy Savings by Minnesota Utilities in 2015

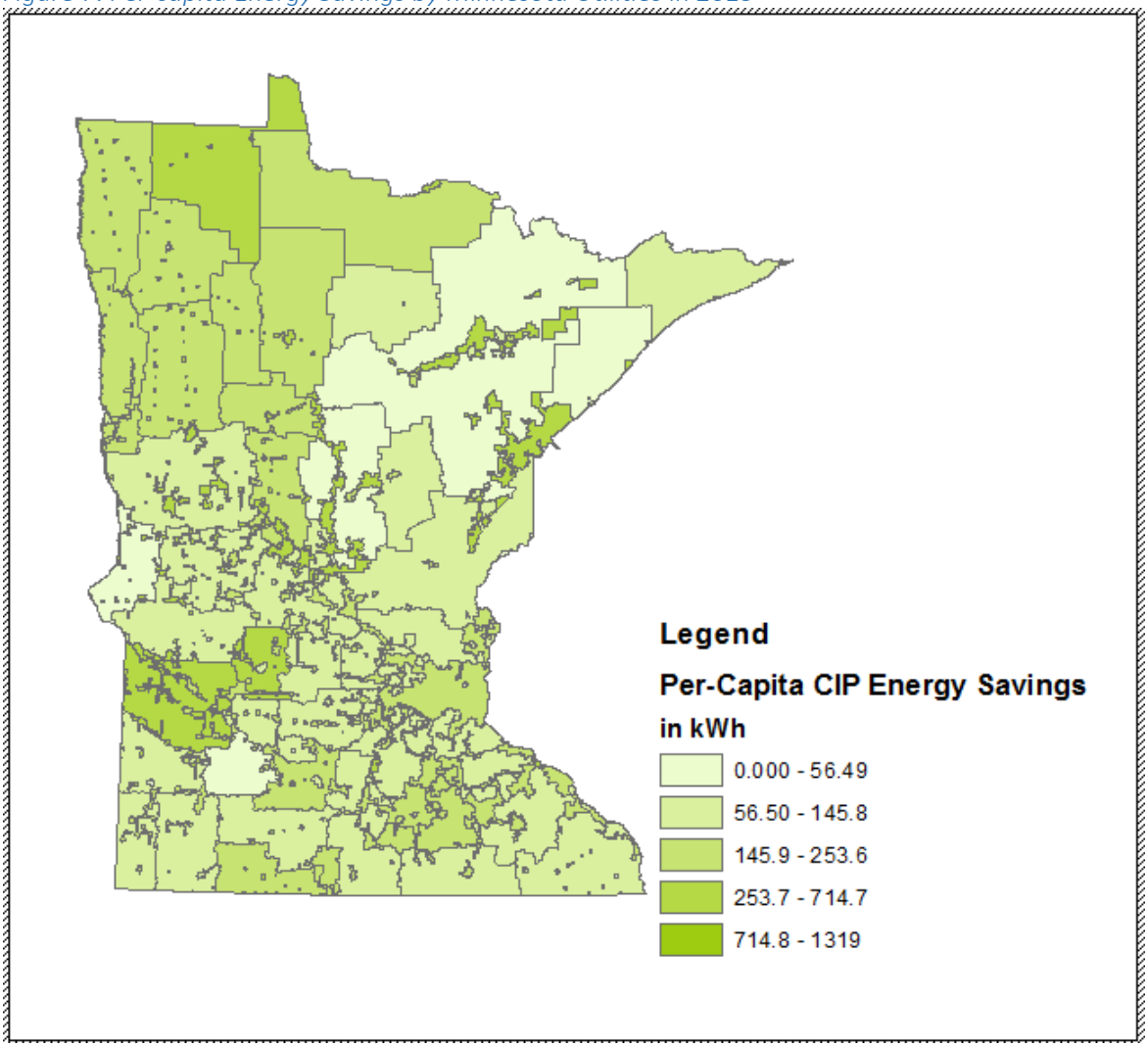


As one can see, the results are skewed because Xcel Energy sells about a half of the total electricity in Minnesota. It makes sense that their service territory has by far the most energy savings across the state. This gives a skewed picture of CIP in Minnesota because it shows that mainly the metro area is the only place with significant CIP energy savings. This message would not play well with one of Commerce's key stakeholders of interest, skeptical legislators. These legislators are generally in outstate Minnesota, outside of the Xcel service territory. This means that the map shown in Figure 6 could potentially give evidence that CIP is not effective in outstate Minnesota. Overall, that is a message Commerce would like to avoid.

To ameliorate the argument that CIP only works in the metro, I used population statistics of the

EUST utilities in order to normalize the data. This is easily done on ArcGIS Online via an enrich feature exists that allows the user to add census data to polygons. Thus, I added the estimated 2017 population numbers into the polygons of the EUST. Then I was able to create new attributes in ArcGIS that creates per-capita statistics for the various attribute fields. As seen in Figure 7 the per-capita data shows a better picture of CIP that shows benefits distributed across Minnesota.

Figure 7: Per-capita Energy Savings by Minnesota Utilities in 2015



Step Five: The Odd Shape Problem – and County Level Estimates

The utilities on a map of Minnesota with a lot of detail meaning that the shapes of these service territories are quite unique. These utility shapes, seen in Figure 6 and 7, are not easily recognizable to a wider audience. My solution was to create Minnesota county-level maps that had an estimate of CIP

performance data of the electric utilities in the county. This process took a lot of trial and error and required a lot of work in ArcGIS Online, Excel, and ArcGIS. Here are the general steps I took to create the county-level data needed to create county level CIP maps.

First, I located a Minnesota county shapefile on the state's geospatial website. Then on ArcGIS Online I used the union tool to overlay the electric service territories onto the various counties in Minnesota. It is important to use the EUST map that has the CIP data already joined to it. I then enriched the new union layer to add the same 2017 population statistic I used for the EUST shapefile. Now I had created a new shapefile of about 1,300 polygons. This shapefile had to be simplified.

Next, I created a new Excel document that would calculate the amount of estimated CIP savings in each new polygon – each polygon represents a EUST unique to the county. To do this I used the population percentage of the EUST that is located in each county relative to the total population of the EUST. I did this simple calculation in Excel and then used that to calculate the relative total of the CIP data at the county level.

For example, the Coop utility Stearns Cooperative Electric Associated has about 81.575% of its utility's population in Stearns County. Thus, I used the 81.575% proportion to calculate the estimated savings and spending numbers in Stearns County from Stearns Cooperative Electric Association.

While this is one way to estimate the electric service territory data at the county level, it is only an estimate and does not reflect the actual CIP performance in the counties. The actual CIP performance data in Minnesota counties does not exist. I am using population statistics in the county because it is easy to calculate these numbers and because population shows a reasonable and valid estimate of CIP performance. However, if Commerce staff comes across a different and/or more valid method to estimate CIP performance at the Minnesota county level, then Commerce would be able to update the estimates.

Next, I sorted the service territories by county and added up the total numbers for the entire county. I then created a second Excel document with county as the first field and the CIP performance totals from the previous Excel document added as new attributes under the county. I then converted this county-level Excel document with the cumulative CIP data into a CVS Excel document. The data was now ready to merge with the original Minnesota county shapefile. I joined the shapefile with the county CVS Excel file, this join is based on the county name attribute. This results in a shapefile that will be able to display estimated CIP performance data at the county level. This map is easier for the public and legislators to understand because the county is a recognizable and standard shape.

Step Six: Story Map

Now that I had the CIP data into EUST and county level shapefiles – I was ready to present my maps in ArcGIS Online. This simple process allowed me to import many maps into a Story Map. Here I was able to display the maps on the four identified benefits that CIP brings to Minnesota. Along with the maps – I was able to draft qualitative information describing the benefits CIP has in Minnesota. I was also able to add some pictures and infographics to better display the results.

It is a difficult task to describe the 'Story Map' in text. The best way to get a sense of my mapping project is to see the Story Map. The ArcGIS Online Story Map can be seen at the following link: https://arcg.is/10L1r1

Conclusion and Next Steps

In short, my project achieved its goals. Energy efficiency is an important policy tool for decreasing energy demand and improving the economy. CIP has a long and important history establishing an EERS in Minnesota. CIP has performed well in Minnesota, but it is difficult to display the results of CIP in easy to understand ways. My Story Map shows CIP results in a way that has never been seen, using ArcGIS Online and estimating the county-level CIP results. Going forward there are many

opportunities to expand this project and tweak the messaging. While the maps may not be enough to convince legislators to keep or expand the EERS in Minnesota – it will help Commerce staff and other stakeholders get a better understanding of CIP.

Going Forward

One of the best parts about this project is that there are many opportunities to improve and expand the CIP mapping/messaging. I am fortunate that I will most likely be employed at the Commerce Department for another year to continue working on this project. Two tasks can help improve this project. This is not an exhaustive list of what can be completed. These steps represent two important topics that would greatly improve the project and could be completed without an extensive amount of research.

Create Senate and House district CIP maps

Given that one of the most important external stakeholders for this project is the Minnesota Legislature, it makes sense that CIP data should be displayed on Senate and House district maps. This would give a representative or senator more detailed information on how CIP performs in his/her legislative district.

These maps could be created with a similar process that was used to create the CIP county-level maps. This process would require estimation based on population percentages of the electric utilities service territories in the House and Senate districts. Thus, while the results would be estimations they would not require significant new research to complete.

Senate and House district maps could also be enriched to provide more information that would be helpful for a legislator. Some helpful information that could be presented on the 'pop-ups' on ArcGIS Online could include poverty statistics, demographic information, number of businesses, and percentage

of population using a delivered fuel (like propane) to heat their residence. The 'pop-up' also could display the names and types of utilities that are currently operating in the member's legislative district.

Disaggregate Residential and Commercial/Industrial Sales and Savings

One of the key limitations of my project is the methodology used to calculate county-level CIP results. In short, I used the population percentage of the electric utility service territories at the county level as a base to calculate and aggregate CIP spending and savings numbers. However, a problem persists, because population percentage does not necessarily equate to the percentage of total energy sales, CIP savings, and CIP spending in an electric utility service territory. For example, Minnesota Power may have most of its population in Duluth, but may sell more energy in the Iron Range, due to the industrial nature of the customers in that area. Thus, the results at the county-level may be biased because the estimation is based on population and not actual energy sales/savings in the county. This is not to say my previous work is invalid; I contend that population percentage produces a valid estimation of CIP performance at the county level, given data limitations. However, going forward there may be a better way to disaggregate the CIP savings/spending numbers into two segments, residential and commercial/industrial.

Disaggregating CIP information would be challenging and time consuming. There is no easy way to disaggregate the CIP savings and spending information from the COUs in Minnesota – they are reported at the utility level. Getting this data would require work in ESP to manipulate the program reported totals to aggregate the CIP savings and spending into the residential and commercial/industrial segments. However, COUs report total energy sales at the segment level, meaning it would not be too challenging to calculate the total sales numbers at the segment level. Interestingly enough, IOU data is almost the exact opposite of COU data. IOUs report CIP savings and spending at the segment level, but report total energy sales at the aggregate CIP level. More research is required to find segment-level IOU energy sales data.

The goal of this task would be to provide CIP performance results at the county level (or senate or house district level) with more detail and certainty. It is hard to say if the results would be significantly different from the already calculated totals at the aggregate level; but they would be provide a better understating of CIP performance in Minnesota.

These were just two possible expansion of the work already completed for this project. There are many more opportunities to expand and improve this research with the goal of presenting CIP information to wider audiences while still presenting quality information about the program.

Sources

Berg, W. (2016). The 2016 state energy efficiency scorecard. *American Council for an Energy Efficient Economy, U1606*. Washington, D.C.

Cadmus. (2015). *The aggregate economic impact of the conservation improvement program 2008-2013.* St. Paul, MN: Minnesota Department of Commerce. Retrieved from: http://mn.gov/commerce-stat/pdfs/card-report-aggregate-eco-impact-cip-2008-2013.pdf

Downs, A., & Cui, C. (2014). Energy efficiency resource standards: A new progress report on state experience. *American Council for an Energy Efficient Economy, U1403*. Retrieved from http://aceee.org/sites/default/files/publications/researchreports/u1403.pdf.

Gillingham, K., & Palmer, K. (2014). Bridging the energy efficiency gap: policy insights from economic theory and empirical evidence. *Review of Environmental Economics and Policy, 8*(1), 18-38. Retrieved July 1, 2017.

International Energy Agency. (2014). *Capturing the multiple benefits of energy efficiency*. Paris. Retrieved from https://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEficiency.pdf.

Minnesota Department of Commerce, Division of Energy Resources. (2016). Minnesota conservation improvement program: energy and carbon dioxide savings report for 2013-2014. St. Paul, MN: Minnesota Legislative Library. Retrieved from https://www.leg.state.mn.us/docs/2017/mandated/170154.pdf

Minnesota Environmental Quality Board. (2016). *Climate solutions and economic opportunities*. St. Paul, MN: Revisor of Statutes. Retrieved from https://www.revisor.mn.gov/statutes/?id=216B.241&format=pdf

Minnesota Geospatial Commons. (2015). Electric utility service areas. St Paul, MN: MN IT Services. Retrieved from ftp://ftp.gisdata.mn.gov/pub/gdrs/data/pub/us_mn_state_mngeo/util_eusa/metadata/metadata.html.

Minnesota Legislative Library. *(2016).* Energy conservation improvement statute. 216B.241. St. Paul, MN.

Minnesota National Governors Association. (2014). *Minnesota clean energy economy profile*. Retrieved from https://mn.gov/deed/assets/mn-cleanenergy-economy-profile-fullreport_tcm1045-133120.pdf

Minnesota Public Utilities Commission. (2016). Docket # G999/CI-08-133. Minnesota eDockets.

Pimentel, D. (2004). US energy conservation and efficiency: benefits and costs. *Environment, Development and Sustainability, 6*(3), 279-305. Retrieved July 1, 2017, from https://link.springer.com/article/10.1023/B:ENVI.0000029887.33339.65.

United States, Energy Information Administration. (2017, February 1). *Energy efficiency and conservation*. Retrieved July 1, 2017, from https://www.eia.gov/energyexplained/index.cfm/index.cfm?page=about_energy_efficiency#tab2

U.S. Dept. of Energy. (2008). *Understanding cost-effectiveness of energy efficiency programs: best practices, technical methods, and emerging issues for policy-makers: a resource of the National Action Plan for Energy Efficiency*. Washington, D.C

U.S. Environmental Protection Agency, State and Local Climate Energy Program. (2017). *Bringing the benefits of energy efficiency and renewable energy to low-income communities*. Washington, D.C